USE OF RADIO TRANSMITTER IMPLANTS IN WILD CANIDS

Jeffrey S. Green[1], Richard T. Golightly, Jr.[2], Susan Lyndaker Lindsey[3], and Brad R. LeaMaster[1]

Abstract.— Twelve adult and five juvenile coyotes and 20 adult kit foxes were implanted with radio transmitters using relatively simple surgical procedures. Four foxes were successfully implanted in the field. None of the animals implanted exhibited noticeable behavioral effects, and no deaths were confirmed to result from implantation. Implants were attached to the peritoneum in adult coyotes and kit foxes and were left free-floating within the abdominal cavity of the coyote pups. Both procedures produced satisfactory results. Radio signals transmitted from implants had less range than those from traditional neck collar transmitters. Implants offered benefits unavailable with traditional collar transmitters: no external packaging to influence behavior, ability to radio monitor small or juvenile animals, and ability to acquire various physiological data on free-ranging individuals.

Implantable radio transmitters have beenused to monitor physiological parameters and movements of numerous mammals (primates, Stone et al. 1972; canids, Golightly and Ohmart 1983; ursids, Jessup and Koch 1984; mustelids, Melquist and Hornocker 1979, Melquist et al. 1981, Garshelis and Siniff 1983, Eagle et al. 1984; sciurids, Eagle et al. 1984, Golightly and Ohmart 1978; castorids, Davis et al. 1984; and others, Folk et al. 1971). Implants may offer advantages over externally attached transmitters such as a decreased effect on animal behavior, ability to instrument small or juvenile animals, and ability to acquire physiological data. One disadvantage of implantation is surgical risk to the animal. Techniques of implantation have been described for several species, yet there is a lack of detail concerning the implantation procedure and effectiveness of implants for monitoring physiological parameters and movements of canids.

In this paper we report the results of two independent studies using implants in wild canids. In one study (authors JSG, SLL, and BRL) implants were used to monitor the movements of juvenile coyotes (*Canis latrans*), and in the other (author RTG) implants were used in adult coyotes and adult kit foxes (*Vulpes macrotis*) to monitor body temperature (Golightly and Ohmart 1983) and location (Golightly 1981).

Study Areas and Methods

Coyote Pups

Five pups (two male, three female) were obtained from two captive litters in two 65-ha enclosures at the U.S. Sheep Experiment Station, Clark County, Idaho. Pups were 100–136 days old and weighed 3.7–5.8 kg. Each pup was pretranquilized with 2.2 mg/kg xylazine (Rompun) intramuscularly and 0.05 mg/kg atropine sulfate subcutaneously. Induction and surgical anesthesia were obtained by administering 16 mg/kg thiamylal sodium intravenously until a desired plane of anesthesia was reached. Each pup was placed in dorsal recumbency and its abdomen shaved from the xyphoid process to the pubis. This area was washed, and a 4-cm incision through the skin was made caudal to the umbillicus. The peritoneal cavity was entered through the linea alba by a short incision made with a scalpel and extended with blunt-tipped scissors. Each transmitter (22 g cylinder, 6 cm long, 2 cm diameter; Telonics, 932 E. Impala, Mesa, AZ 85204) was presoaked for approximately 15 minutes in a disinfectant solution (Nolvasan) and inserted into the peritoneal cavity.

The peritoneum and internal and external rectus sheaths were sutured with a simple interrupted pattern using size 00 chromic gut.

[1]U.S. Department of Agriculture, Agricultural Research Service, U.S. Sheep Experiment Station, Dubois, Idaho 83423.
[2]Department of Wildlife, Humboldt State University, Arcata, California 95521.
[3]Department of Zoology and Entomology, Colorado State University, Fort Collins, Colorado 80523.

The superficial fascia and skin were repositioned with a simple interrupted pattern of 0 chromic gut. Each pup was given a prophylactic injection of 150,000 units of procaine penicillin G and 150,000 units of benzathine penicillin G (1 cc Benza-Pen) intramuscularly. Two days later the pups were given a second 1-ml dose of the antibiotic and released into the enclosures.

From August 1982 through May 1983 performance of the implanted transmitters was compared with that of 10 collar-mounted transmitters (weight 290 g; Telonics) on adult coyotes concurrently within the enclosures. Coyotes were observed from an elevated (9 m) observation booth located at a boundary common to both enclosures. Signals were received with a phase-combined stacked array of two 5-element beams, 15.5 m above the ground. Maximum distance from transmitter to receiver was 1.14 km. Signals were classified as good (signal strong, direction easily determined), fair (signal of medium strength, direction difficult to determine), poor (signal audible, unable to determine direction), or no signal.

The implants were recovered when the coyotes were recaptured nine months following implantation. The surgical procedure for removal of the implants was similar to the implanting procedure.

Coyote Adults

In 1977, 12 adult coyotes (10 male, 2 female) weighing 9.1–12.7 kg were captured near Phoenix, Maricopa County, Arizona, and immobilized with a mixture of 1.25 mg/kg ketamine hydrochloride (Ketaset), 0.5 mg/kg Rompun, 0.12 mg/kg Acepromazine, and 0.006 mg/kg atropine sulfate administered intramuscularly. A surgical plane of anesthesia resulted in 5–7 minutes. The peritoneum was opened in a manner similar to that described for pups, and a temperature-sensitive transmitter (13 g, 5.7 by 2.4 by 1.7 cm; J. Stuart Enterprises, Grass Valley, CA 95965) was inserted. A length of size 0 Vetafil ligature was run through a loop of Vetafil attached to the transmitter, and both ends of the ligature were held by clamps outside the incision. The ligature was then tied to the peritoneum 1 cm lateral to the superior end of the incision, thus securing the transmitter to the peritoneal wall. The peritoneum and the linea alba were closed with a running suture of size 0 chromic gut. Powdered Furacin was applied to the sutured incision. The skin was then closed with mattress sutures of size 0 Vetafil, and Betadine ointment was applied to the suture line. Following surgery, 75,000 units of Bicillin were administered intramuscularly. Coyotes were confined to cages for 12 hours before being released into a 0.13 ha enclosure at Arizona State University.

To remove an implant, an incision was made similar to the one described previously. The ligature was located, clamped, and cut, the implant was removed, and closure was accomplished as described previously.

Kit Foxes

In 1978 and 1979, 12 kit foxes (five male, seven female) were captured near Apache Junction, Pinal County, Arizona, implanted with transmitters, and released in a 0.13-ha enclosure at Arizona State University. Eight additional kit foxes (three male, five female) were captured and released into the wild following placement of an implant and a conventional neck-collar radio transmitter (110 g, Telonics). Body weights of kit foxes ranged from 1.4 to 2.4 kg.

Kit foxes were immobilized with a mixture of 2 mg/kg Ketaset, 0.25 mg/kg Rompun, 0.25 mg/kg Acepromazine, and 0.012 mg/kg atropine sulfate administered intramuscularly. Anesthesia resulted in 3–5 minutes. The implant and implantation procedure as previously described for adult coyotes was used. Following surgery, 25,000 units of Bicillin were administered to each animal intramuscularly. Kit foxes were released into their dens or into the enclosure 6–8 hours following surgery. Four of the foxes released into the wild were implanted in the field; otherwise, all surgeries were performed in a laboratory.

Results and Discussion

Coyote Pups

We did not observe any behavioral changes or mortality resulting from implanting coyote pups. Implants provided an advantage over collars in that we were able to equip each pup with a transmitter at a young age. This made capture more efficient and less stressful to the animal since young pups usually retreated to a den from which they were dug, and older animals usually ran until cornered or exhausted. Also, data on sex, weight, physical measurements, and movement were obtained earlier than if coyotes had been captured after they reached adult size when conventional radio collars could be used. (Expandable neck collar transmitters may also be used on juveniles.)

Three disadvantages of implants were recognized. The transmitted signals from the implants (58% rated good, 21% fair, 7% poor, 14% no signal, n = 254) were not as strong as those of the collars (93% good, 5% fair, 1% poor, 1% no signal, n = 630). However, the implants were usually adequate for identifying location or direction of the pups. Second, use of a motion-sensing option with the implant would have necessitated attachment of the implant to the abdominal wall (probably more extensive than the attachment described previously for adult coyotes and kit foxes). We were unsure of the risk (e.g., internal complications) involved with such a procedure. Third, the implants had an approximately two-thirds shorter operational life than collar transmitter packages (based on data from Telonics).

When the time came to remove the implants from the coyote pups, three of the four implants were floating freely within the abdominal cavity and the fourth was encased within a thin membrane. There was no evidence of trauma or irritation of tissue adjacent to the site of implantation.

Although coyote pups were implanted at 3.5 and 4.5 months of age, implanting comparably sized transmitters would likely be possible in coyote pups as young as 2–2.5 months.

Coyote Adults

From 1977 to 1980, 21 transmitter implantations were performed on 12 adult coyotes. Each implantation procedure lasted approximately 30–35 minutes. Postsurgical infection requiring medical attention developed in only one instance. All coyotes appeared healthy and fed normally during the 2–4 month experimental periods following implantation. One female successfully produced a litter of two pups while carrying an implant.

Serial implantations (replacement of an implant in each of six coyotes) resulted in moderate scar tissue and made final retrieval surgeries slightly more difficult.

The ligature attachment did not cause apparent damage to internal organs or to the peritoneum, and it facilitated retrieval of the implant through a relatively small incision. Some experimental conditions (e.g., where public visibility is a concern or in heat exchange studies) necessitate that a small surgical site be prepared, thus potentially making retrieval of a free-floating implant difficult. Attachment of the implant to the peritoneum reduced time in surgery and trauma during recovery or replacement of implants. This might be an important consideration with rare species or animals that are difficult to obtain.

The attachment also provided a consistent location for measurement of body temperature. Some experiments require accurate measurement of relatively small differences in body temperature with implanted transmitters (Golightly 1981). Body temperature varied at locations within the abdominal cavity of mammals during arousal from hibernation (Lyman et al. 1982), and body temperature of normothermic mammals may vary at different locations within the body. It would be particularly important to attach implanted transducers for measuring heart or respiration rate.

The transmitters were effective in providing information on body temperature to remote receiving locations outside the enclosure. Signals were routinely received with a hand-held Yagi antenna at a distance of 70–100 m from the animal despite the presence of physical barriers (i.e., brick walls, rock piles) between the transmitter and the receiver.

Kit Foxes

Sixteen transmitters were implanted into foxes in the enclosure, including four serial exchanges (two implants in each of four foxes). The surgery lasted approximately 20–35 minutes. The kit foxes were observed every 2 or 3 days, and infections were not evident. The animals maintained weight and appeared healthy. One female died of undetermined causes while carrying the implant. No pathology was evident upon necropsy, and the tissue around the implant appeared normal.

Two males developed hernias at the site of incision several months following implantation. The transmitter may have physically stressed the site of incision and caused or contributed to the hernia. Both foxes had received replacement implants. One fox had continued problems with the hernia following repair of the surgical site. Because kit foxes have a thin peritoneum compared with that of coyotes, we suspect that the serial implantations precipitated the hernias. Four of the eight free-ranging kit foxes died during the study but none from transmitter-related causes.

All foxes appeared to feed normally and maintain weight, and some moved substantial distances at night (maximum distance of approximately 21 km in a single night, Golightly 1981). No infections were observed. One free-ranging female was implanted early in pregnancy and carried the implant for four months while successfully whelping and rearing a litter of three pups.

A signal transmitted from an implant normally could be received 75–100 m away from foxes in dens (1–2 m underground), whereas transmitters affixed by neck collars could be received 500–700 m. Outside dens, signals from implants and collars were received at 200+ m and 1,000–2,000 m, respectively.

Implants were useful for obtaining body temperature data and for determining movement within a den after the fox was located with the signal from the neck collar. Implants were not useful as a sole means of locating kit foxes. However, kit foxes should be able to accommodate the larger implant described previously for coyote pups, which would perhaps increase their range of transmission.

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